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Estimation of Public Service Cost Functions for Nonmetropolitan Utah Counties

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ESTIMATION OF PUBLIC SERVICE COST FUNCTIONS

FOR NONMETROPOLITAN UTAH COUNTIES

by

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Lyle G. Johnson

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ABSTRACT

Estimation of Public Service Cost Functions for

Nonmetropolitan Utah Counties

by

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Utah State University, 1977

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The purpose of this paper is to test the hypothesis that economies of scale exist in the provision of government services in nonmetropolitan Utah counties. Financial data from the counties was analyzed using statistical methods. Total expenditures, general government, public safety, public works, libraries, health and welfare, parks and recreation, and roads are examined.

(76 pages)

CHAPTER I

INTRODUCTION

In recent years nonmetropolitan Utah has experienced a growth in population. One source of growth has been the development of energy resources, such as coal and oil shale. The development of planned projects such as the Kaiparowits power plant and the alunite processing complex in Beaver County will mean large population increases in some areas. In addition, since 1962, there has been a tremendous increase in the development of recreational subdivisions.

This growth will have impact in many areas. Of importance is the impact on existing social institutions in the growing regions. New people moving into the area may bring values and ideas that conflict with the present ones. An example of this is the concern expressed by community leaders about the development of the Kaiparowits project and the effect that new people in the area would have on their children.

The most controversial issues in this topic involve the environment. Much concern has been expressed about the environmental impact of energy development. Examples are questions about air quality with coal-burning power plants and waste disposal in oil shale production. Other environmental problems involve soil erosion that results from development of mountainside and water pollution. The effect of population growth on wildlife is often mentioned.

Also of importance are economic considerations. The major source of income for county governments is the property tax. When people move into an area outside of existing towns, the county is expected to provide the services normally provided by city governments. These include law enforcement and fire protection, road building and maintenance including snow removal, and utilities. The claim has been made that long-time residents of a county are being forced to pay the way for new residents of a county. Opponents of growth argue that property taxes on the newly developed land, which naturally are higher than before the land was developed, are not enough to cover the increased costs to the county of providing the services in the new area. This claim is made in an article prepared by the State Division of Community Assistance, Department of Community Affairs (22), which states that in a county of 5,000 people an increase in population of 1,000 people may increase county costs as much as 50 percent.

It is this paper which prompted the idea for this thesis. There is in economic theory the concept of economies of scale. It has been used as an explanation of why cities tend to grow larger and why some industries are dominated by a few very large firms. The question is whether or not economies of scale exist in nonmetropolitan Utah pertaining to the provision of public services.

With rapid growth projected for some Utah counties, whether or not economies of scale can be expected is important in preparing for this growth. Economies of scale, as used in this thesis, may be defined as lowering per capita costs with increasing population. This would help those involved in planning for the growth or in administration capacities to make wise policy decisions that would make the growth process as painless as possible. The purpose of this thesis is to determine whether or not economies of scale exist in rural Utah in the provision of public services, with the hope that those involved in decision making in this area may be able to make better decisions that affect the future or nonmetropolitan Utah and the lives of its people.

CHAPTER II

THEORY OF ECONOMIES OF SCALE

The theory of economies of scale, part of modern production economics, is concerned with the combining of inputs to produce goods and services. The purpose of this chapter is to review the theory of economies of scale, to use production functions to show how returns to scale may vary, to discuss the theory of vertical and horizontal integration, and to show how these concepts apply to the services and goods supplied by various governmental units.

Perhaps the best way to look at the effect of scale changes and to examine economies of scale is through the use of production functions. One of the properties of the production function is its homogeneity sometimes referred to as the returns to scale parameter. The easiest way to understand homogeneity is through the use of a production function

$$q = f(K,L) \ .$$

If for a production function both inputs are increased by the same proportional λ, it follows that

$$\lambda^{\alpha} f(K,L) = f(\lambda K, \lambda L)$$

or

$$\lambda^{\alpha} q = f(\lambda K, \lambda L) \ .$$

If $\alpha = 1$, then the function is homogenous to degree 1;

if $\alpha > 1$, then the function is homogenous to a degree greater than 1; if $\alpha < 1$, then the function is homogenous to a degree less than 1.

A production function that is homogenous of degree 1 would show constant returns to scale. A production function homogenous of a degree greater than 1 would show increasing returns to scale. A production function that is homogenous of a degree less than 1 would show decreasing returns to scale. The most commonly used production function in economic literature is the Cobb-Douglas production function

$$q = aK^{\alpha}L^{1-\alpha} .$$

By varying each input in a given proportion (λ), we can see what the effect is on output.

$$\begin{aligned} &a(\lambda K)^{\alpha} (\lambda L)^{1-\alpha} \\ &= a\lambda^{\alpha+1-\alpha} K^{\alpha}L^{1-\alpha} \\ &= a\lambda\ K^{\alpha}L^{1-\alpha} \\ &= \lambda q\ . \end{aligned}$$

This shows that by varying the inputs by a given proportion would result in a change in output of the same proportion, of that the function is homogenous of degree 1.

In order to show economies and diseconomies of scale, Chiang (4) in his text uses a generalized Cobb-Douglas function of the type

$$q = a\ K^{\alpha}L^{\beta}$$

This function differs from the standard Cobb-Douglas function in that it may be homogenous of a degree other than 1. The degree of a homogeneity is the sum of α and β. If $(\alpha + \beta) = 1$, then the function is homogenous to degree 1 and shows constant returns to scale. If $(\alpha + \beta) > 1$, the function is homogenous of degree greater than 1 and shows increasing returns to scale. (f $(\alpha + \beta) < 1$, the function is homogenous of degree less than 1 and shows decreasing returns to scale. This can best be shown using examples. In the first case of constant returns to scale, assume that $\alpha = 0.5$ and $\beta = 0.5$. Thus:

$$q = aK^{0.5}L^{0.5}$$

and increasing both inputs by λ ,

$$\begin{aligned} & a(\lambda K)^{0.5} (\lambda L)^{0.5} \\ & = a\lambda^{0.5+0.5} K^{0.5} L^{0.5} \\ & = a\lambda K^{0.5}L^{0.5} \\ & = \lambda q \end{aligned}$$

results in a proportional change in output.

In the second case of increasing returns to scale, assume that $\alpha = 0.5$ and $\beta = 0.6$. So the production function becomes:

$$q = aK^{0.5}L^{0.6} \ .$$

Varying both inputs proportionally we get:

$$\begin{aligned} & a(\lambda K)^{0.5} (\lambda L)^{0.6} \\ & = a\lambda^{0.5+0.6} K^{0.5} L^{0.6} \\ & = a\lambda^{1.1} K^{0.5}L^{0.6} \\ & = \lambda^{1.1}q \ , \end{aligned}$$

which shows that a proportional increase in inputs would result in a greater than proportional change in output. In the third case of decreasing returns to scale, assume that $\alpha = 0.5$ and $\beta = 0.4$, thus, the function is:

$$q = aK^{0.5}L^{0.4} \; .$$

Varying both inputs by the proportion λ gives:

$$\begin{aligned} & a(\lambda K)^{0.5} \; (\lambda L)^{0.4} \\ & = a\lambda^{0.9} \; K^{0.5} \; L^{0.4} \\ & = \lambda^{0.9} q \; , \end{aligned}$$

which shows that when the production function is homogenous of degree less than 1, proportional increases in all inputs results in less than proportional increases in output.

As stated before, the shape of an industry's long-run average cost curve is important in determining optimal size of operation. There are two ways to determine the long-run average cost curve. The first is to take one firm and follow it through many expansions, observing the marginal and average costs at each different size. The second is a cross-section study of the costs of different firms that already exist within the industry. By plotting the cost curves of all different size plants, it is possible to determine the shape of the long-run average cost curve by drawing a curve that is tangent to the various individual cost curves (see Figure 1).

There are generally three areas in size or scale as long-run average cost curve: (1) an area of increasing return to scale or

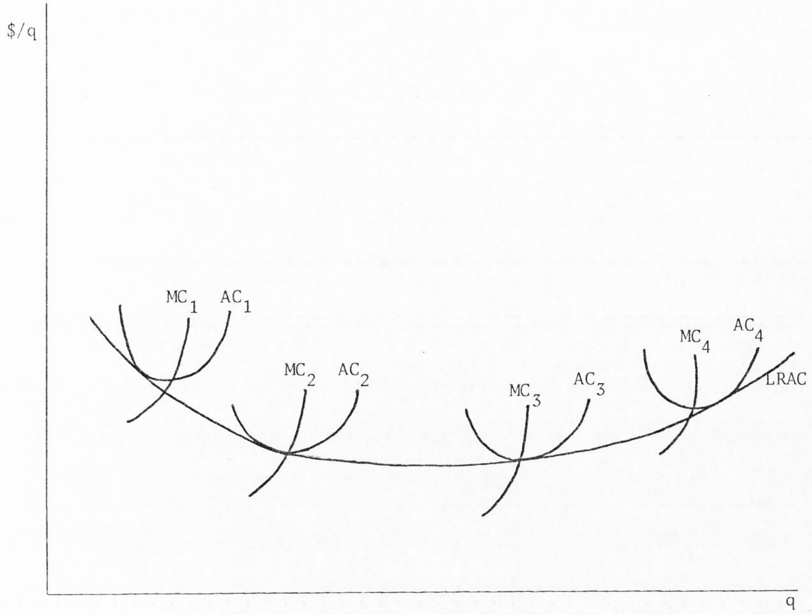

Figure 1. A long-run average cost curve (LRAC)

economies of scale; (2) an area of constant returns to scale; and (3) an area of decreasing returns to scale of diseconomies of scale as shown in Figure 2.

An industry with a long-run average cost curve that showed constant returns to scale as in Figure 3 would be characterized by many firms of different sizes, all of which are efficient. It has been said that American agriculture has this type of long-run average cost curve.

A second type of long-run average cost curve, as shown in Figure 4, drops sharply to a minimum as scale increases and then rises rapidly as scale continues to increase. This type of industry would have many firms all about the same size and all producing at the minimum point on the long-run average cost curve. This is typical of many industries in the United States, including the fast-food restaurant business.

A third type of long-run average cost curve is characteristic of the automobile industry in the United States as shown in Figure 5. It has a long part with falling costs or economies of scale before diseconomies make the curve rise.

The various sections of the long-run average cost curve, as shown in Figure 2, are representative of the different production functions. The negatively-sloped part of the curve is representative of homogeneity greater than 1 and shows economies of scale. The flat part of the curve is representative of homogeneity of degree 1 and shows no economies or diseconomies of scale. The third section or positively-sloped part of the curve is representative of homogeneity of degree less than 1 and shows diseconomies of scale.

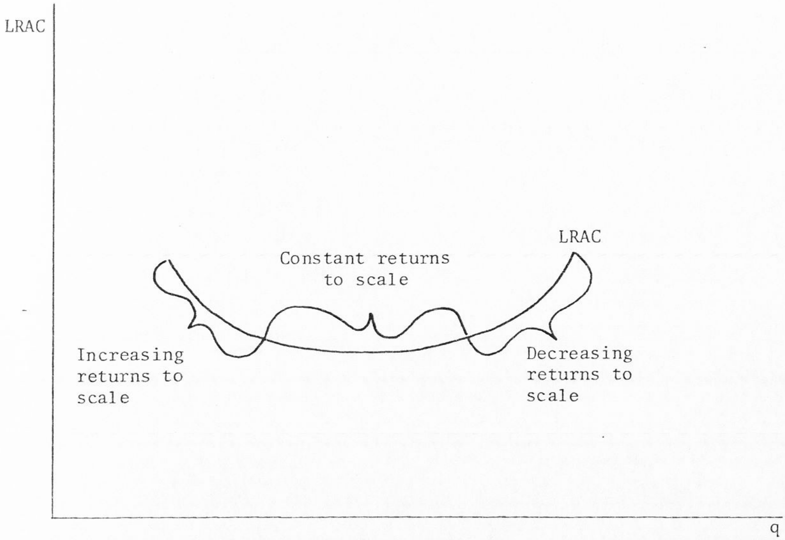

Figure 2. Sections of a LRAC

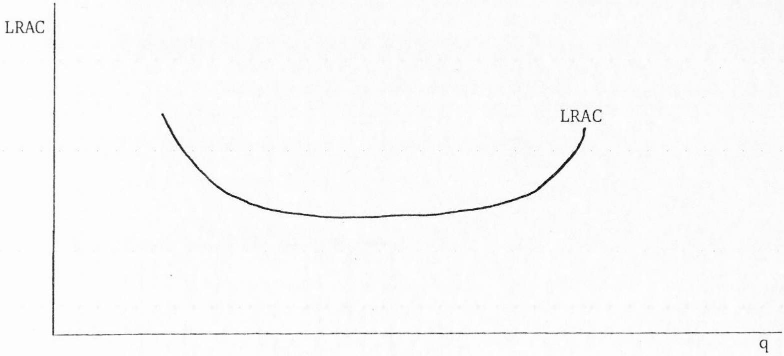

Figure 3. LRAC characteristic of an industry with many firms of different sizes

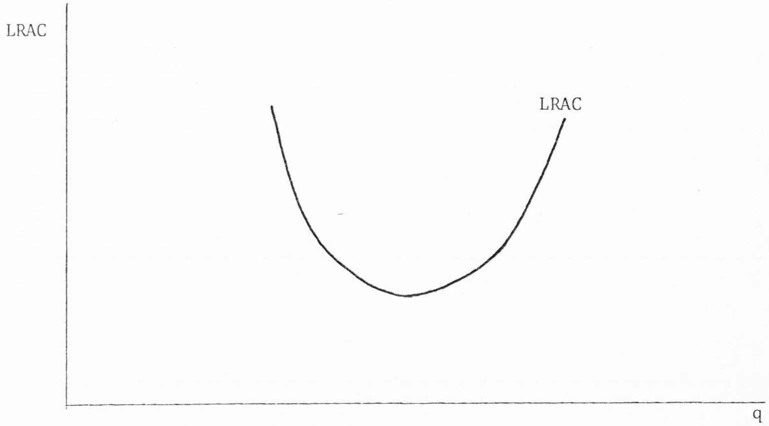

Figure 4. LRAC characteristic of an industry with many similar sized firms

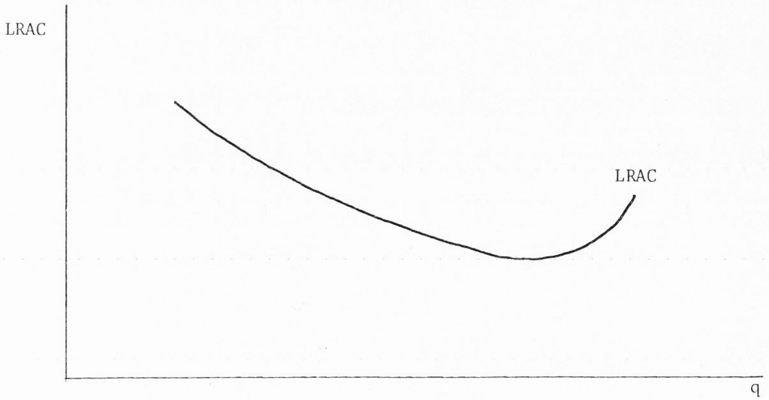

Figure 5. LRAC characteristic of an industry with a few large firms

The returns to scale concept is important in economic theory because it is essential in determining the optimum size of a production unit. Assuming constant technology, there are three possibilities: 1) constant returns; 2) increasing returns; and 3) decreasing returns to scale. The constant returns to scale case is the simplest and easiest to work with. For this reason, it is the most commonly encountered of the three. This case implies that as scale is changed by increasing proportionally all inputs, then output increases by the same proportion. Because costs are the critical element in this thesis, it should be noted that total costs for the competitive firm are proportional to output when there are constant returns to scale.

Although constant returns to scale are typically assumed, they may not reflect actual conditions. The cases of increasing or decreasing returns to scale may be much more appropriate in many situations.

Factors explaining increasing returns to scale include the following: 1) The most obvious explanation as first mentioned by Adam Smith (17) is specialization of men and machines. In a small company, an employee may have to perform several of the many different functions that go into the production of the final good. In a larger plant, the employee may be able to spend all his time performing one function. This allows him to become more proficient at that one job and also eliminates the time wasted by changing tools or in moving about the facility necessary when several functions are performed by the same employee. The larger operation may also allow the use of specialized machinery to perform some of the functions that a smaller operation may not be able to afford.

2) Larger firms may be able to secure reductions in unit costs of inputs by buying in larger quantities and receiving discounts from the supplier. Small firms may not be able to take advantage of volume buying, because they are not able to handle the quantities necessary to receive the discount. 3) Larger firms may be able to take advantage of opportunities for economical use of by-products. A good example of this is the Moroni Feed turkey processing plant in Moroni, Utah. Because the plant is so large and is able to process such a large number of birds in a day, it has become feasible to convert all the waste materials, that before were disposed of by dumping, into a high protein feed supplement for cattle and, in some cases, even turkeys. Smaller plants do not generate the volume of by-products necessary to justify the equipment necessary to produce the feed supplement. Another example, more appropriate to the topic of this thesis is the case of recycling centers operated in conjunction with municipal garbage disposal systems. Larger cities that handle a sufficient volume of materials in a day may find it feasible to separate recyclable items, such as glass and aluminum, and build plants to process these materials, which then can be sold and become a source of revenue that smaller cities without sufficient volume are not able to take advantage of. 4) Larger firms are able to establish or encourage the development of auxiliary facilities that provide needed parts or services at lower cost. 5) Large firms are able to purchase large machines which cost less per unit of output than do smaller machines. 6) There may be unused capacity in some machinery. The example is given in Ferguson's text (5) of a machine that produces 30,000 units a day and a machine which packages 45,000 units a day. When the two machines are

linked together into a production system, there is unused capacity in the packaging machine. A small manufacturer that was able to produce 30,000 units a day would not be able to take advantage of this capacity. Alternatively, a larger plant that produced 90,000 units a day could have three machines producing and two packaging and, thus, have all of its machines operating at full capacity. The long-run average cost would be lower in this case for the producer that was able to operate his machinery at full capacity (5).

Only two reasons are commonly used to explain diseconomies or decreasing returns to scale. The most important of these is due to the limitations of management in its decision-making function. In order to make the most effective decisions, the manager responsible must be thoroughly familiar with everything that goes on in the production and marketing processes of his firm. For a small firm, this is relatively easy, but as the size of the firm increases, it becomes increasingly difficult to obtain and understand all of the information necessary to make efficient decisions. Of course, each individual manager has different capabilities; some are able to effectively manage large operations while others can only control smaller operations. It is difficult to determine just where diseconomies that result from ineffective decision making come into the picture, but they are still an important reason why long-run average costs begin to rise. A second reason, external to the individual firm, is that the entire industry may expand so much, through the expansion of the many individual plants all taking advantage of economies of scale, that competitive pressure may force up the prices of inputs used by the industry. In a competitive industry, each firm takes the prices of inputs as given, and, thus, the higher prices caused by the expanding industry would raise the long-run average costs of the firm.

A third possible reason for diseconomies of scale according to Baumol (2) is the existence of externalities. Baumol argues that as population (n) grows, costs of externalities such as pollution and congestion rise at the rate of n^2. He suggests that increases in population size may result in disproportional increases in cost or, in other words, diseconomies of scale.

Another important concept that has an effect on economies of scale, particularly when it concerns goods and services provided by a government unit, is that of integration. There are two kinds of integration, both of which involve growth and expansion on the part of the firm. Horizontal integration is when an organization expands by obtaining more and more production units in the same stage of the production or marketing process. An example of horizontal integration is a chain of grocery stores. Vertical integration exists when a firm expands by moving into different stages of the production and marketing process. Again an example of this is again the Moroni Feed Company, which is completely vertically integrated into all stages of the production process of producing turkeys. They own their own feed mills, their own processing plant, even their own hatcheries.

Firms integrate primarily to take advantage of some economies of scale or to minimize the effect of some diseconomies of scale. Firms may integrate horizontally so they will be able to take advantage of economies of scale caused by buying in larger volume to receive discounts. A growing company may expand horizontally in an attempt to minimize the possible effects of bad management decisions by keeping all parts of the growing company doing the same thing. Alternatively, firms may expand vertically in order to take advantage of some management expertise existent in the company which is not being used to capacity. Vertical integration is also used to bring more stages in the production process under one management and, thus, insure the development of the necessary auxiliary processes. A firm may also integrate vertically in order to insure an adequate supply of input materials.

According to Hirsch (9), the concepts of vertical and horizontal integration are very important when discussing economies of scale in government-provided services. Both types of integration are present, and the effects of population growth may be different upon each type of service. Services such as police and fire protection are generally horizontally integrated services. That is, as a city expands, new police precincts or fire stations are required to provide the needed protection. These are generally spread about in different parts of the city in units of comparable size. Utilities and garbage disposal are generally vertically integrated. A city or county may control all the steps in providing water for its people from the source of the water to the pipes that deliver the water to the individual homes.

To this point most of the discussion of economies of scale has centered around firms in the private sector of the economy and why economies of scale may or may not be expected to exist in their operations. As most government units are involved in the processes of providing goods and services for local residents, it can also be expected that the same factors which cause economies of scale in the production of consumer goods to also give rise to economies of scale in the production of goods and services by governments. The major difference between the sectors being how scale is measured. In the private sector, scale or size is generally measured by the amount of assets a company controls or by the number of units that are produced in a given time period. With government units, perhaps the best measure of size and the factor that determines the necessary scale of operations is population.

There are many ways cities and counties may be able to take advantage of economies of scale. There is excess capacity designed into many public works projects. Thus, a new sewer or water system may be able to service a larger population than currently lives in the area. As the population grows, the capital costs are spread over more people, lowering per capita costs. Government units of sufficient size may be able to take advantage of specialization of men and machines. Where a small town may use a flat-bed truck for garbage hauling on Tuesday and for road maintenance on Wednesday, a large city may be able to have specialized garbage trucks that make the work much easier and the men that operate them can specialize in one operation, rather than being required to perform many.

As discussed above, as cities grow, some of their production units expand horizontally and others expand vertically. The economies of scale that affect one group may not affect the other. The horizontally integrated groups are generally the service-oriented functions such as police and fire protection, and welfare and social services. The nature of these services is such that a given number of policemen, social workers, or others is required for so many people in the city. It is conceivable that economies of scale may not be as evident in this group as in the other set of vertically integrated services. The latter includes those city services which provide a product such as electricity or water. Expansion of these units can generally be accomplished by installing larger machines or expanding the city's capacity to provide these goods as the need arises. For these reasons, it can be expected that economies of scale may be more obvious in these vertically integrated services.

Of course, in government services there exists the possibility of diseconomies of scale for the same reasons that diseconomies of scale appear in other industries. A city may grow so large that the managers in charge of the city's operations may find it difficult to make effective decisions. Problems of information from one group to another in the city's structure may further complicate the job of decision making.

As shown in this chapter, economic theory would suggest that economies of scale or increasing returns to scale may exist in many industries. It is the hypothesis of this thesis that economies of scale do exist in nonmetropolitan Utah counties in the provision of goods and services by county governments. It is hoped that the acceptance or rejection of this hypothesis might help decision makers in these counties to perform their jobs better.

CHAPTER III

REVIEW OF LITERATURE

Introduction

The purpose of this chapter is to review the relevant literature on the specification and estimation of public service cost functions for local governments. The theory of economies of scale has been discussed in the previous chapter. It is now appropriate to summarize some of the models that have been developed to predict expenditure behavior by local governments and review the empirical work in the field. A discussion of the issues surrounding the local government consolidation issue concludes the chapter.

Models and empirical evidence

There have been several models developed to explain the behavior of government expenditures. Many also take into account the revenue side of the problem but that is outside the scope of this project. Hirsch (10) reviews a number of studies and then speculates about the shape of the long-run cost functions for some city services. He argues that average cost curves for police protection, libraries, schools, and parks can be expected to be U-shaped with considerable flatness. He concludes, that for such services the flat part of the curve or minimum per capita cost appears after a small minimum size and that there are no substantial economies of scale following. He does indicate that there are possible economies of scale for very large cities in the production of water and electricity which are vertically integrated services as opposed to the horizontally integrated services like police, fire, and administration.

Fisher's (6) work was primarily an empirical study but he did provide a theoretical base. He argued that per capita expenditures for state and local governments are a function of: population per square mile or density; the percent of the state living in urban places; and per capita income. Using regression analysis and data drawn from the 1957 Census of Governments, he found that when using general expenditures as the dependent variable, density had a negative relationship whereas degree of urbanization and per capita income both had positive regression coefficients. Several categories of state and local expenditures were also analyzed. He found that the population density parameter was negatively associated with per capita expenditures on highways, public welfare, health and hospitals, and sewage disposal, but that density had a positive coefficient in the police and fire protection equations.

Figher's objective was to explain differences in expenditure levels between states. He found these three variables explained a significant part of the variation. The negative correlation of density to service costs is particularly relevant to this project since as county populations grow, density is greater.

Kurnow (12) extended Fisher's work. He argued that an additive model of the form $y = a + b_1X_1 + b_2X_2 + b_3X_3$ as used by Fisher was inappropriate and that a multiplicative or log-linear model of the form $y = AX_1^{b_1} X_2^{b_2} X_3^{b_3}$ was better. Using the same data as Fisher, the latter model was able to account for a significantly greater portion of the total variation among state expenditures than was the simple linear model. Kurnow also modified the model to include the following explanatory variables: per capita personal income; degree of urganization; per capita federal aid; and student-teacher ratio. Although the equational statistic, R^2, was not significantly higher using these variables, the model was better able to predict state expenditure levels.

In 1967, an attempt was made by Selma J. Muskin and Gabriel C. Lupo (14) to project state and local government revenues and expenditures to future dates. Their work was part of an attempt to develop national growth models and project to 1970 some 100 different expenditure components and about half that many revenue items. Their particular task was to project the state and local government sectors of the economy. Only the expenditures part of their paper will be discussed. They assert that there are four methods that can be used to project expenditures.

> 1. The historic rate of increase in expenditures can be extended into the future in total or per capita terms.
>
> 2. For areas where potential recipients of the service can be identified, the future beneficiary load can be projected separately and multiplied by the observed relationship between expenditures and per capita income.
>
> 3. Increase the number of variables used in projection to analyze the factors affecting demand for and supply of different categories of services.
>
> 4. Define a standard unit of service in each functional area (such as hospital beds, or number of classrooms). The work load in each program is projected into the future, as a function of assumptions about economic and demographic variables, and program scope. Then the work load is combined with a projection of cost per unit which again reflects the underlying assumptions about economic and social changes, and increases in quality of public services. (p. 239)

The fourth method was used by the authors in their work.

Although there is no model presented or specific results given, their methodology may be helpful in determining demand for government services that might result from population growth. It could be useful in a study such as this in determining demands for services as growth is experienced in the various counties in Utah.

Gabler's (7) research on the relationship between size and per capita expenditures is especially germane. In this study three variables--city size (population), population density, and rate of population change--were the primary explanatory variables. It was recognized that two problems exist in this type of work: cities differ in financing arrangements between state and city and between the city and other governments; and there are differences between cities in providing varying mixes of services. To minimize these problems he examined total expenditures on common functions, i.e., police, fire, highways, sanitation, sewerage, and parks and recreation. The author further distinguished between current operating expenditures and capital outlays, separating out the latter wherever possible. Another set of explanatory variables were used which seemed relevant: percentage of population 65 years of age or over; median school years completed by those 25 and older; and median family income. These latter variables are included as an attempt to estimate the preference and demand for government services. Gabler considered two sets of observations: cities with population of 25,000 to 250,000; and cities having more than 250,000 inhabitants. By comparing city size and per capita costs in Ohio, Texas, and New Jersey, it was concluded that there were no significant economies or diseconomies of scale in either group.

Of the three population parameters, the growth rate of population was most relevant and showed diverse relationships in many expenditure categories. A direct relationship was found between median family income and expenditures, percentage of population 65 and over showed a positive relationship but level of education generally acted as a negative factor. Gabler concluded that there is a tendency for larger cities to have higher levels of per capita spending. A large variation between states was found (7).

This paper seems to suggest that there is a long flat part of the long-run average cost curve for public services that runs somewhere between 25,000 and 500,000 and that the curve eventually turns upward, suggesting diseconomies of scale beyond the higher population figure. Although Gabler's paper does not include spatial units with population less than 25,000 people, economic theory would suggest that there would be a falling portion of the cost curve to the left of this figure. These low population units will be the focus of this thesis as many of Utah counties have populations between 1,000 and 25,000 people.

In his article entitled "Local Government Expenditures: A Social Welfare Analysis," Henderson (8) attempts to explain public expenditure and tax decisions which result from maximizing a social welfare function subject to a social budget constraint. Per capita public expenditures, per capita private expenditures, community per capita income, per capita revenue from state and federal governments, population, and taxes are variables in the model which mathematically maximizes a welfare function subject to an expenditure constraint.

Henderson used data from the 1957 Census of Governments and the 1967 Census of Population to test his model. Several different topics were examined but of most relevance to this thesis is the effect of population. With population, as with most other categories, it was found that a great difference existed between metropolitan and nonmetropolitan counties. As population increased, it was found that metropolitan counties increased per capita local expenditures, whereas non metropolitan counties reduced local expenditures, taxes, and debt while increasing private expenditures. The conclusion was reached that population size is a significant variable in explaining variations in expenditures of different government units.

Walters (24) presents a model suggesting that long-run average cost should fall with increased scale. Some of the problems that might be encountered when attempting to estimate cost functions are listed. Among them are: separation of short-run cost from long-run cost; measuring entrepreneurial ability; differences in accounting periods and economic periods, tax laws and depreciation of capital items; valuation of capital services at historical cost rather than current prices; and use of engineering data in construction of cost curves.

The research emphasizes the differences distinguishing between cross-section and time series studies. In time series, changes in demand must be taken into account while in cross-section there are no independent forces working on all units. Walters also reviews the literature which tends to support the assertion that long-run average costs are generally falling or constant for public utilities which is claimed to be clearly established evidence of the existence of economies of scale for that sector.

In Chapter II, it is pointed out that there are two methods of constructing long-run average cost curves. A cross-section of counties or time series data for a single area which shows population changes can be used. Because of the difficulty in obtaining time series data, the cross-sectional method will be used in this study.

In a study particularly relevant to this thesis, Walzer (25) analyzes economies of scale in police services in municipal Illinois. Two problems are identified in most of the previously work. The first involves the definition of economies of scale and whether or not the private and public sectors are comparable. In the private sector, economies of scale are thought of as being associated with a declining long-run average cost curve but this is not defined as clearly for the public sector. The second problem outlined is measurement of quality. Many researchers tend to look at measures as police officers per capita when another quality indicator may be more relevant. In a cross-sectional study such as this, the question of quality differences is especially important. It is difficult to measure quality of services and compare them among governmental units. The lack of good indicators of quality for many of the areas considered is a major problem and the cost of obtaining accurate information about service in most Utah rural counties is prohibitive.

Walzer uses a regression model that has scale of operations, population density, ratio of police officers to population, ratio of offenses cleared to arrests reported, average wage paid to recruits, and land area of the city as explanatory variables. The scale of operations index is constructed as a weighted composite of the number of offenses cleared, number of accidents investigated, and miles traveled by police vehicles. A significant negative relationship between this scale parameter and cost was found but the coefficients are small. Also, a positive relationship was found between costs and the number of police officers per capita and the population density parameters. As a further test, regression analysis was used for the same years to explain per capita expenditures as a function of population. A negative relationship was indicated but in no case was it significant. The conclusion is that there was a need for more work to be done to establish a proper scale measurement for police services.

Much of the research has presented contradictory evidence about the existence of economies of scale in government services. Some report that economies of scale can be expected while others say there are diseconomies. There appears to be two relevant points on this issue. First, most of these articles deal with urban centers having population levels in excess of 25,000; and second, they examine a large number of different expenditure categories. It is possible, however, to draw some generalizations from this review. It could be expected that economies of scale, defined as decreasing per capita costs with increases in population size, exist in a number of services among which are water, electricity, sewage treatment, and garbage disposal, which are vertically integrated services. Further, there is a second, larger group of services that could be expected to show no change in cost with increases in population. These are government services such as fire and police protection that can be classified as being horizontally integrated. It is noteworthy that many researchers found that there are diseconomies when examining the experience of very large cities.

There is a gap in the literature concerning the shape of the long-run average cost function on low population areas. However, there are many general statements about small counties implying that this group of counties has trouble financing the services they provide and further implying the existence of high costs. For example, Shapiro (16) says, "the most serious problems have arisen in those governmental units with very large or very small numbers of people residing within their jurisdictions." Klindt and Braschler (11) state:

> Predominantly rural counties in the United States have had increasing difficulty in financing local governments and in providing essential services to rural residents. According to a report of the Committee for Economic Development, 2,700 counties out of a total of over 3,000 in the United States are predominantly rural. One-third of the total have populations under 10,000, while more than two-thirds have less than 25,000 and more than nine-tenths have less than 50,000 inhabitants. (p. 2)

The recommendations that are offered as solutions to the high cost problems, among which are encouraging economic and population growth, and consolidation of government units, indicate that many economists and others believe that small counties are on the declining part of the long-run average cost curve and measures that encouraging greater populations will help in reducing costs.

Low population areas and the case for consolidation

In one of the few articles focused on rural counties, Klindt and Braschler (11) discuss the implication of consolidation. As pointed out previously, 2,700 out of 3,000 counties in the United States are predominantly rural and have small populations. It has been recommended that these small counties be combined into units of 50,000 people. The purpose of this study was to determine what affects the costs and revenues of county governments, develop ways to determine the effects of consolidation, and provide a framework to determine what the relevant issues may be. The records of four counties in southeastern Missouri were used in an effort to determine what the relevant issues were.

In Missouri, counties are required by state law to allocate their funds by classes with Class I expenditures having priority over Class II expenditures, etc. The following are the expenditure classes as outlined by state law:

Class I: Care of pauper insane;

Class II: Juries and elections;

Class III: Roads;

Class IV: Salaries and office expenses;

Class V: Contingencies and emergencies; and

Class VI: Equipment and other legal expenses.

Roads were eliminated from this study because of the existence of special road districts in the state which are separate from the counties.

Two reasons were given why consolidation is suggested as a means of lowering county costs. The first is that the operation of county governmente could be made more efficient. For example, the administrative and clerical personnel of one county may be able to handle the work of the several counties that are combined. This could result in the elimination of several of the administrative and clerical offices and, thus, make government more efficient by lowering costs. The second is that combining counties would increase population and allow economies of scale associated with population increases are also associated with increased density and that combining counties into one government unit would not change the density. Another important point is that as distances in a county increase, costs are higher, so consolidation may not be the answer to the problem. It was found in examining four rural counties in Missouri that there were no savings from consolidation in Classes I, II, or III expenditures but that there was small savings in Class IV, around two dollars per capita. Savings were also found to be unequal between the two counties that were to be consolidated. The county that retained the county seat had the lower costs. This research suggests that consolidation may not be as effective as originally thought in reducing county costs.

Some support to the Kindt and Braschler position is given by White and Tweeten (26) in reporting their work with schools. Although some school districts in Utah do not have the same boundaries as counties, consolidation is also an important issue in this area. White and Tweeten point out that school districts often exhibit a declining long-run average cost curve for education (instruction, administration, plant operation and maintenance, buildings, and equipment). Curve $LRAC_E$ in Figure 6 is such a curve. At the same time, transportation costs rise as size increases. This is particularly true in sparsely populated areas. This is shown in Figure 6 by the curve $LRAC_T$. The total long-run average cost curve for the district is the sum of the two curves (curve $LRAC_{E+T}$ in Figure 6). By determining the minimum point on this curve, it is possible to determine the optimum size for the school district. Thus, density and area are very important in questions of consolidation.

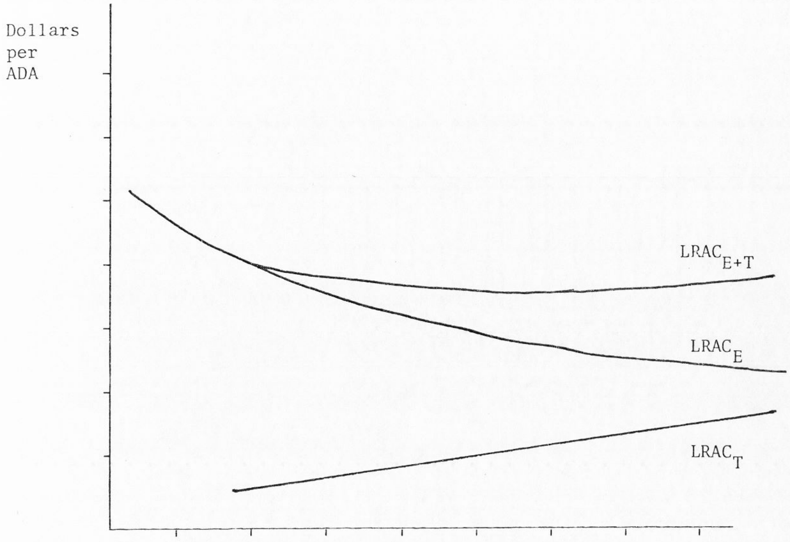

Figure 6. LRACs for education.

The same type of analysis could be applied to the question of consolidation of counties. In counties with large land areas and ver low density, like most of the nonmetropolitan counties in Utah, transportation and communication costs could easily offset any efficiency gains made in administration of county government.

<u>The problem of quality</u>

A topic that logically would seem to be important but which is almost ignored in the literature is that of quality of services. Most researchers find that quality is too difficult to measure and so forget about it. Hirsch (9) is one of the few to say anything about this problem. In his public finance text he states that quality is very difficult to measure and that in most cases where attempts are made, value judgments are usually involved. He suggests that probably the best method for measuring quality is to use proxy variables. Examples include square miles covered per pumper or ladder company in fire protection hospital beds per 1,000 population and patient days in health services; and frequency and pick-up location for garbage disposal. These and other proxies that might be developed may be used to measure qualities of public services. Even though such variables are rough estimates, they are perhaps the best available at the present time. This clearly is an area where much more work is needed.

The real question is one of how quality differences affect the cost of services between different government units. In studies involving different states or even cities in different states quality differences may be an important factor. However, this study, where all the units are within the same state and similar in governmental structure, the quality problem becomes less important. This is especially true where there are state and federal guidelines that establish quality standards for the counties. Also in Utah there are regional associations of county governments that tend through mutual cooperation to make quality of services more uniform throughout the state.

A second question in measuring quality is the availability of data to use as proxies. In many cases this data is not available. An important concept in economics that can be applied here is that of benefit cost. If the benefits gained from using quality measures in research are greater than what it costs to obtain these measures, then they should be included. If it costs more to obtain the measures than the increase in benefits that result from their use, then it is better not to use them. Each researcher confronted with this problem must examine the costs and benefits of using quality parameters in his work and make his decision using the above principle. In this study it was decided that to gather this kind of information would cost more than would be returned in significant knowledge.

Although this thesis does not cover the subject of optimum population size for a county in Utah, it is relevant. The typical answer to the question of optimal size is that population allows a county to be at the low point on the long-run average cost curve.

Concerning the topic of optimum size, Alonso's work as explained by Lewis (13) is very applicable. Alonso considers the city as an aggregate productive unit and that output is the value of total product in the area including public and private sectors. Costs are harder to define, and would include quantity and price effects in the cost of infrastructure and municipal operation, in the costs of exogenous inputs other than human ones into the city's economic activity, and in private consumption. A series of cost and product curves are offered by Alonso and reproduced here in Figure 7 that are useful in examining the question of optimum size (13).

Four population levels are shown which are of interest. P_1 is the minimum efficient city size. Cities with populations below P_1 could be expected to find it difficult to support themselves and experience declining populations. This may be an explanation of the demise of many small towns in rural areas. P_2 is the city size that generates minimum average cost and is the obvious answer to the above question. P_3 is the population size which maximizes per capita income. P_4 is where the cities' contribution to GNP is a maximum. Using these points, the question of optimum size becomes a question of from what point of view the question is asked. For some concerned with the survival of small towns, P_1 may be the optimum. For others another size may be considered more desirable.

An extension of Alonso's argument may be taken to explain how cities can grow very large. By using a specialized production function, it is possible to get the situation where average costs are rising but at a rate less than average product (see Figure 8) so that P_4 is never reached and cities continue to grow to extremely large sizes.

Conclusions

The studies reviewed have developed many different models in an attempt to determine if economies of scale exist in public services. Many different variables are used; population, density, and degree of urbanization are common to the majority of them. Most found U-shaped,

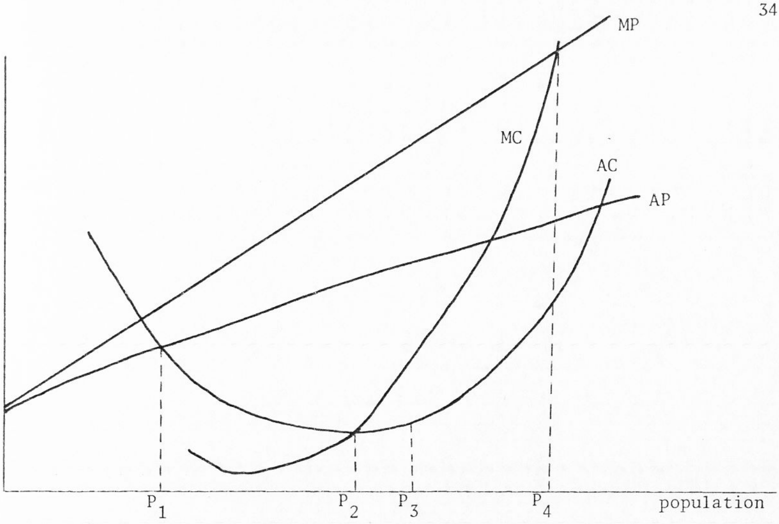

Figure 7. Cost and production curves.

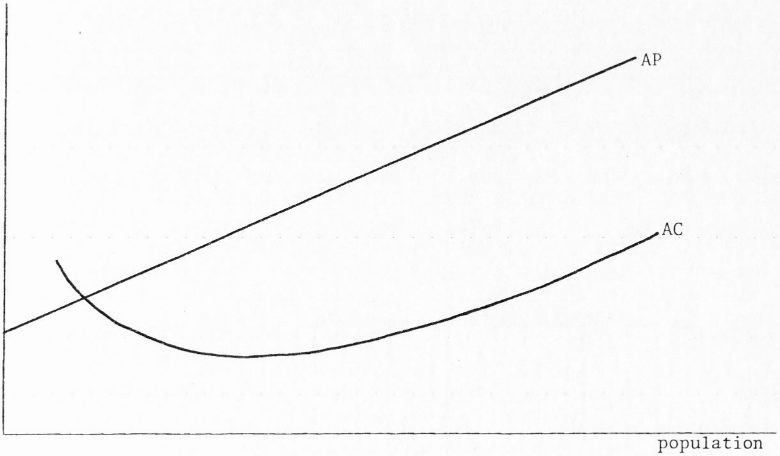

Figure 8. Average product and average cost curves.

long-run average cost curves when per capita expenditures are plotted against population. Many have a long flat part which starts between 10 and 25 thousand people and ends at around 500 thousand. Very small areas and very large areas tend to have higher costs per person than intermediate sized areas. This evidence tends to support the hypothesis of this thesis that lower per capita costs can be expected in the larger counties of Utah and that most low population counties can be expected to be somewhere on the negatively sloped portion of their long-run average cost curves.

This thesis will fill in two places in the literature where very little work has been done. First, most of the research in this area has been concerned with cities and their costs. Secondly, researchers have tended to ignore areas with low population and have concentrated their efforts on metropolitan areas. It is hoped that this thesis will help in understanding the situation of counties rather than cities and particularly counties that are nonmetropolitan in nature.

CHAPTER IV

PROCEDURES

In the previous chapter, it was stated that the null hypothesis to be tested is that economies of scale exist in nonmetropolitan Utah concerning the production and provision of goods and services by county governments. In order to test this hypothesis, a series of long-run average cost curves (functions) are specified and estimated.

Functions are estimated for each of the following governmental services: total expenditures, general government, public safety, public works, health and welfare, library, parks and recreation, and roads.

The following models were used to test the hypothesis:

Total expenditure = f (population, area, density, urbanization, education, income);

General government = f (population, area, density, urbanization, education, income);

Public safety = f (population, area, density, urbanization, education, income);

Public works = f (population, density, urbanization, education, income);

Health and welfare = f (population, density, urbanization, education, income);

Library = f (population, density, urbanization, education, income);

Parks and recreation = f (population, density, urganization, education, income); and

Roads = f (population, area, density, urbanization, income, road miles).

The variables used are essentially the same as those used by other researchers and incorporate the effects of both scale and demand factors upon public expenditures. Population was chosen as the measure of scale. A negative relationship between population and per capita expenditures will be taken as evidence of economies of scale. Area is included in some of the equations as a measure of the distances involved in the counties. A positive relationship is expected for area. Density is included as both a scale and a distance variable. Higher density counties generally have greater populations and in higher density places more people can be served per unit of time or distance than in low density areas. A negative relationship between density and per capita expenditures is expected. Urbanization is a variable that denotes the percentage of a county's population that live in towns or cities with populations greater than 2,500 people. It is included because in many cases counties and cities provide duplicate services. A negative relationship is expected in this case because as more people live in towns and cities, the counties are called upon to provide less services than if the people lived outside of the cities. Education and income are included in an attempt to measure demand differences between counties. A positive relationship is expected in both cases.

As is stated in Chapter II, there are two methods of constructing a long-run average cost curve, a time series method and a cross-sectional method. Because of the nature of the available data that were collected, and because of the difficulty of obtaining data from years before 1970, it was decided to derive a series of three cross-sectional cost curves for each of the categories. The method used to construct these cost functions was ordinary least-square regressions of the data points for the cross-section of nonmetropolitan counties in the state of Utah.

Of major importance to the analysis of this topic was the choice of which type of regression function to use. Two functional forms were considered:

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

and the log-linear function:

$$y = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} .$$

The linear form was chosen because the statistical results were superior to the log-linear form.

In order to empirically test the hypothesis it was necessary to obtain expenditure data for the counties of Utah. The Utah State Auditor's Office has compiled this information from annual financial reports submitted by counties. On the reports expenditures are divided into several categories: total expenditures; unappropriated surplus; general government; public safety; public works; health and welfare; library; parks and recreation; roads; capital improvements; debt; service; and general obligation bonded indebtedness. The hypothesis was tested using these data.

Besides the county expenditure data, other data that were necessary include population estimates for the years 1970, 1971, 1972 such as: per capita income in the counties; age of population; education; road miles; land area of the county; density; and degree of urbanization. Density, degree of urbanization, area, and road miles are variables which show scale. The demographic variables are included as demand variables that may vary from county to county. Area and road miles were obtained from the report of the Utah Foundation. Density was figured by dividing population by area. The rest of the data were obtained from the City-County Data Book compiled by the federal government. Population estimates came from the Bureau of Economic and Business Research.

A problem that was encountered in the statistical interpretation of the data for this thesis was the presence of extreme variation in expenditure levels between years for a few of the counties. The presence of one extremely large value can significantly distort the value of the coefficients obtained when regression analysis is used. Figure 9 shows how a large value distorts the slope of the least-square regression line.

Figure 10 shows that by eliminating the extreme value and again using regression technique, a line may be obtained which better fits most of the points.

In Utah there are five counties that are classified as Standard Metropolitan Statistical Areas, hereafter referred to as SMSA counties. They are Salt Lake, Davis, Weber, Tooele, and Utah Counties. To be classified as an SMSA, a county must have a city or twin cities with a population of over 50,000 people and exhibit certain urban characteristics. A county with less than 50,000 people can be included in the SMSA

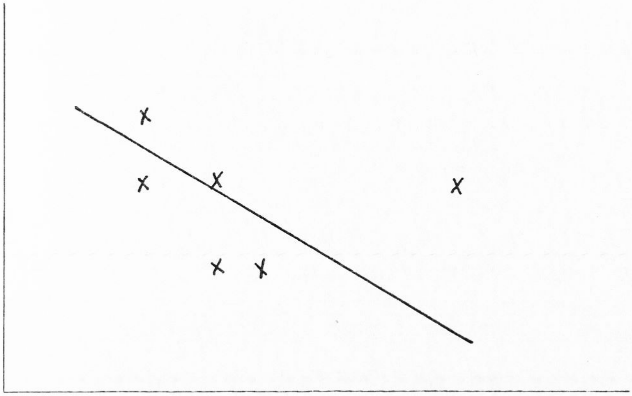

Figure 9. Effect of a large value on the slope of a least-squares regression line.

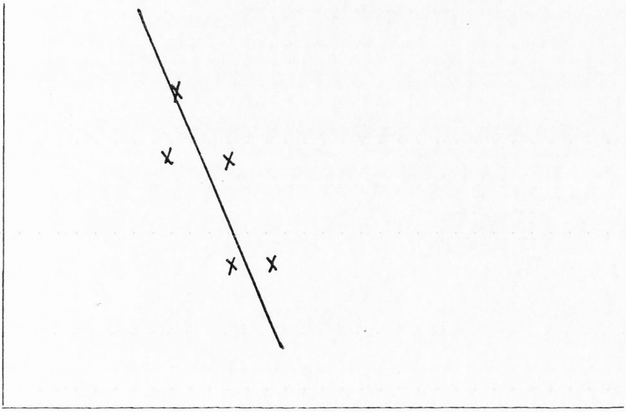

Figure 10. Least-square regression line with large value removed.

if it can be shown through the use of commuting patterns and other methods that the county is significantly affected by the presence of the city. This is the case of Tooele County and Salt Lake City.

The rest of the counties in Utah in 1970 ranged in population from 666 to 42,331 (see Table 1). It was determined that the SMSA counties with populations of over 100,000 persons represented extremely large values as compared to the rest of the counties, so these counties were excluded.

In order to test the basic hypothesis, it is necessary that the counties of Utah be similar enough that they can be analyzed together without serious problems arising because of differences. It was felt that the SMSA counties are sufficiently different from the smaller, predominantly rural counties that removing them from the data set was justified.

In the financial data, a few of the counties showed extremely large values in one of the years as compared with the other two. Wayne County is an example. Table 2 shows total expenditures in Wayne County for the three years of the study.

Per capita total expenditures in Wayne County in 1972 were twice the 1971 level. Without knowing the reasons for such an increase, it was felt that the 1972 value was an extremely large value and would effect the significance and usefulness of the results. For this reason, Wayne County data were removed from the 1972 analysis. In 1972, data from Rich County were not available and 1972 Wasatch County data were not available and data from Daggett, San Juan, Washington, and Wayne were removed because it was felt they were so much larger than the other years data to constitute extremely large values.

TABLE 1

NONMETROPOLITAN UTAH COUNTIES

County	1970 Population	County	1970 Population	County	1970 Population
Daggett	666	Juab	4,574	Sevier	10,103
Piute	1,164	Emery	5,137	Sanpete	10,976
Wayne	1,483	Wasatch	5,863	Iron	12,177
Rich	1,615	Summit	5,879	Uintah	12,684
Kane	2,421	Grand	6,688	Washington	13,699
Garfield	3,157	Millard	6,988	Carbon	15,647
Beaver	3,800	Duchesne	7,291	Box Elder	28,129
Morgan	3,983	San Juan	9,606	Cache	42,331

TABLE 2

PER CAPITA TOTAL EXPENDITURES IN WAYNE COUNTY

Year	P/C Total Expenditures
1970	$123.40
1971	151.30
1972	300.00

To test the hypothesis, it was necessary to make two assumptions. The first is that the counties of Utah form a relatively homogenous group. This means that the counties must be similar in many ways. As mentioned before, the SMSA counties were eliminated from this study because they are different from the rest of the state. The rest of the counties of Utah are similar in most respects. With very few exceptions the rural counties of Utah have a common base of agriculture as the major source of income. Most areas of Utah were settled by the same type of people and there are common ethnic and cultural ties. Most exhibit few urban characteristics, and most have the same type of county government, that of elected commissioners. The only major differences in the counties is in terrain and climate. This may affect expenditures on roads because of things like snow removal but is not a large enough objection to warrant the rejection of this assumption.

The second assumption was reviewed in Chapter III. In order to test the hypothesis with the data obtained, it becomes necessary to assume that quality of goods and services is constant from one county to another across the state. This assumption may not be as unrealistic as it first appears. Because the counties and people are similar, the same mix of services is provided in essentially every county, and because of state and federal regulations and guidelines most programs are fairly consistent between counties. Also, because of the lack of good quality measurement parameters and because of the difficulty of obtaining data about quality, it seems reasonable that this assumption be accepted.

In order to test the hypothesis of this thesis, a series of long-run average cost functions was specified. If it can be shown with statistical significance that the long-run average cost curves are negatively sloped over the population ranges of the rural Utah counties, then it can be maintained that there are economies of scale in the provision of government goods and services.

CHAPTER V

EMPIRICAL TEST OF THE HYPOTHESIS

In the previous chapters, economic theory and the work of economists in this area have been developed to derive the null hypothesis. The empirical methodology used in the testing of the hypothesis has been explained. In this chapter the results of the analysis will be presented and the hypothesis will be accepted or rejected according to usual statistical standards. Accepting the hypothesis means that the null hypothesis is rejected. The statistical results will be given in tabular form showing an estimated equation for each of the three years analyzed, 1970, 1971, and 1972. The coefficients for the various variables are given with the t-values below them in parentheses. Also shown are the F-values and the coefficient of determinization (R^2) for each equation. Eight categories of expenditures were examined: total expenditures, public safety, public works, general government, library, health and welfare, parks and recreation, and roads.

The first category examined was total expenditures. It was hypothesized that total expenditures are a function of population, area, density of population, degree of urbanization, the mean income in the county, and the level of education, i.e., total expenditures = f(population area, density, urbanization, income, education). The null hypothesis is that the coefficient of the population is zero. A negative coefficient significantly different from zero will be taken as evidence of economies of scale. Density and urbanization were also expected to have negative coefficients. Area, income, and education were all expected to have positive coefficients.

Table 3 shows that, as expected, population has a negative coefficient. The coefficients for the 1970 and 1972 equations are significant at the 0.05 level and the 1971 equation is significant at the 0.10 level. As hypothesized, area has had positive coefficients which were significant in all cases. Density, urbanization, income, and education all had positive coefficients but were insignificant in explaining the variation in total expenditures. Applying an F-test to the equation shows that the 1970 and 1972 equations are significant at the 0.05 level but not the 1971 equation. Because of the significant negative coefficients on the population variable, the hypothesis that there are economies of scale in total expenditures is accepted. The magnitude of the population coefficient shows that as population grows by 1,000 persons, per capita total expenditure can be expected to drop between $4 and $5.

The second category examined is general government. As before, the population variable is used to denote scale and if it has a significant negative coefficient, economies of scale are assumed to exist. The equations tested in this case was:

General government expenditures = f(population, density, urbanization, income, education).

Least-squares regression estimates of this equation are shown in Table 4.

TABLE 3

TOTAL EXPENDITURE EQUATIONS 1970-1972

Year	Constant Value	Population	Area	Density	Urbanization	Income	Education	R^2	F
1970	-206.79 (.668)	-.004* (2.393)	.009* (2.128)	2.17 (1.00)	.213 (.896)	.0049 (.838)	19.40 (.750)	.5231	3.107*
1971	-115.06 (.299)	-.004[b] (1.972)	.0073[a] (1.355)	1.99 (.764)	.101 (.438)	.0073 (1.01)	11.7 (.365)	.4584	2.257
1972	-448.50 (1.147)	-.0054* (2.847)	.012[b] (1.887)	3.148 (1.254)	.449[a] (1.446)	-.0042 (.386)	45.927[a] (1.428)	.6464	3.656*

The level of significance for the estimated coefficients in the above table and in the subsequent tables is given as follows:

a = significant at the 0.20 level;

b = significant at the 0.10 level;

* = significant at the 0.05 level; and

** = significant at the 0.01 level.

TABLE 4

GENERAL GOVERNMENT EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Density	Urbanization	Income	Education	R^2	F
1970	-67.724 (1.014)	-.000995** (3.569)	.621[b] (1.912)	-.0626 (1.239)	.0044* (3.442)	5.148 (.935)	.6842	7.798**
1971	-15.788 (.282)	-.00078** (3.384)	.2617 (.984)	-.0196 (.464)	.00196[b] (1.834)	-.159 (.0345)	.6797	7.215**
1972	-55.325 (.545)	-.00079[b] (2.063)	.147 (.331)	.017 (.212)	-.0015 (.578)	8.203 (.964)	.5230	2.851

As hypothesized, the population variable has negative coefficients and is significant at the 0.01 level for 1970 and 1971 and at the 0.10 level for 1972.[1] Income and education all were expected to have positive coefficients. The results were generally as expected. But the significance of the coefficients is low. Income is significant in the 1970 and 1971 equations suggesting that as incomes rise in an area, more public goods and services are demanded. Density and urbanization are included as variables because it is felt that as density increases, distances between people decreases; thus, it becomes easier and cheaper to provide public services; and as urbanization increases, cities provide some of the services provided by counties in less urbanized places, thus allowing county costs to drop. As expected, urbanization tended to have negative coefficients but density had positive coefficients. Significance was very low in both cases. The F-test of the significance of the equations showed that the 1970 and 1971 equations are significant at the 0.01 level but that the 1972 are not significant. Because of the significance of the 1970 and 1971 equations and because the population parameter is negative in all three years, the hypothesis that economies of scale exist is again accepted.

It was questionable if the hypothesis would hold true for public safety expenditures. Many researchers found that economies of scale did not exist in provision of police and fire protection. However, in order to be consistent, the hypothesis of the thesis was retained for this

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[1]It is customary in economics to test significance to the 0.01 and 0.05 levels. This, however, is merely arbitrary, and it was felt in this case that testing to the 0.10 and 0.20 levels added much to the interpretation of the results.

category. The equation tested was:

Public safety expenditures = f(population, area, density, urbanization, income, education).

Population, density, and urbanization were expected to have negative coefficients, and income and education were expected to have positive coefficients. The results of the least-squares analysis of the per capita expenditures on public safety is presented in Table 5.

Surprisingly, the population variable did have negative coefficients in all three years and was significant at the 0.05 level in 1970 and 1971 and at the 0.01 level in 1972. Area was found with some significance to have a positive effect on per capita expenditures. Density again was positive with some degree of significance, and urbanization tended to have negative coefficients with very low significance. Income again was shown to have a positive relationship with expenditures on public safety. The F-tests for the equations showed that they were significant at the 0.01 level for 1970 and 1971 and the 0.05 level for 1972. The hypothesis that there are economies of scale in the provision of public safety services in nonmetropolitan Utah was accepted.

The model to analyze public works expenditures proved to be a very poor predictor. The equation used was:

Per capita public works expenditures = f(population, density, urbanization, income, education).

Population, density, and urbanization were predicted to have negative coefficients while income and education were predicted to have positive values. Table 6 shows the least-squares estimates of the coefficients of the variables in this equation.

TABLE 5

PUBLIC SAFETY EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Area	Density	Urbanization	Income	Education	R^2	F
1970	6.212	-.000263*	.000299	.214[a]	-.00698	.00115**	-.093	.6045	4.331**
	(.345)	(2.652)	(1.207)	(1.695)	(.506)	(3.344)	(.490)		
1971	.863	-.000235**	.000378[a]	.196	-.00920	.000969**	-.130	.6073	4.124**
	(.052)	(2.666)	(1.629)	(1.174)	(.726)	(3.105)	(0.938)		
1972	-28.118	-.000427**	.000774*	.385*	.00358	.00163*	1.859	.6618	3.914*
	(1.231)	(3.796)	(2.120)	(2.628)	(.197)	(2.512)	(.990)		

TABLE 6

PER CAPITA PUBLIC WORKS EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Dnesity	Urbanization	Income	Education	R^2	F
1970	-1.509 (.0168)	.000340 (.907)	-.397 (.909)	-.170* (2.507)	.00636** (3.700)	-2.707 (.366)	.5139	3.805*
1972	142.095 (.817)	.000121 (.171)	-.316 (.383)	-.193[b] (1.471)	.00446[a] (1.347)	-2.601 (.879)	.2566	1.174
1973	130.716 (.850)	.000318 (.550)	-.369 (.549)	-.0707 (.579)	.00635[a] (1.568)	-13.643 (1.083)	.2322	.7907

As shown in Table 6, very few of the variables have any significant relationship at all to the level of public works expenditures. In fact, the only significant variables are urbanization in 1970 and 1971 and income in all years. The urbanization coefficients are negative as was predicted, and the income coefficients are positive as predicted. The population variable has positive values in all three equations, and using the students t-test the significance of the coefficients is very low, thus, the null hypothesis is accepted in this case, indicating that economies of scale do not exist in the provision of these services.

The model also proved to be a poor predictor of library expenditures. In this equation, per capita library expenditures were said to be a function of population, density, urbanization, income, and education. As was the case in other equations, population, density, and urbanization were expected to have negative coefficients, and income and education were expected to have positive coefficients. The least-squares estimates of the library equation are reported in Table 7.

Although there are no estimated coefficients significant at even the 0.20 level, a few general ideas can be inferred from these equations. Density and urbanization tend to have negative coefficients while income and education tend to have positive coefficients. The population variable shows a positive relationship to per capita costs in library services, and, therefore, the null hypothesis must be accepted.

The equations for two categories, health and welfare, and parks and recreation, show very few significant coefficients. The least-squares estimates of these coefficients are shown in Tables 8 and 9.

TABLE 7

PER CAPITA LIBRARY EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Density	Urbanization	Income	Education	R^2	F
1970	15.295 (1.341)	.0000128 (.268)	-.0624 (1.126)	-.00201 (.233)	.000259 (1.189)	1.179 (1.255)	.2361	1.112
1971	-7.406 (.633)	.00000485 (.101)	-.0596 (1.072)	.00219 (.248)	.000137 (.613)	.623 (.646)	.1709	.7007
1972	.798 (.0639)	.00000612 (.130)	-.0342 (.627)	.00513 (.518)	.0000265 (.0805)	.0127 (.0124)	.1285	.3833

TABLE 8

PER CAPITA HEALTH AND WELFARE EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Density	Urbanization	Income	Education	R^2	F
1970	-95.328 (.522)	-.000791 (1.037)	.0829 (.0934)	.209[a] (1.514)	-.00239 (.684)	10.212 (.678)	.1669	.7209
1971	-18.110 (.130)	.000620 (1.137)	.173 (.274)	.166[a] (1.651)	.000270 (1.06)	2.317 (.211)	.1704	.6984
1972	44.369 (.295)	-.000805[a] (1.424)	.285 (.434)	.325* (2.723)	-.00582[a] (1.472)	.525 (.0427)	.3933	1.685

TABLE 9

PER CAPITA PARKS AND RECREATION EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Density	Urbanization	Income	Education	R^2	F
1970	5.859 (.241)	-.0000495 (.486)	.0304 (.257)	-.0224 (1.221)	.00165** (3.533)	-1.311 (.653)	.4477	2.918*
1971	1.070 (.0311)	-.0000250 (.177)	.0291 (.178)	-.0410[a] (1.580)	.00115[b] (1.479)	-.514 (.181)	.2534	1.154
1972	-4.022 (.119)	-.0000842 (.665)	.0584 (.397)	-.00623 (.233)	.000282 (.318)	.369 (.314)	.0720	.2018

The population variables in these two categories tends to have negative coefficients giving some support to the hypothesis of economies of scale, but significance is so low that the null hypothesis must be accepted.

The final category of expenditures is roads. The equations for per capita road expenditures are shown in Table 10. The equation estimated is:

Road expenditures = f(population, area, density, urbanization, income, road miles).

Population density and urbanization were expected to have negative relationships with expenditure levels while area, income, and road miles were expected to have a positive relationship. Population was found to have negative coefficients that were significant. Density had a positive coefficient while urbanization had negative; but in both cases the coefficients are statistically insignificant. Area is shown to have a positive relationship with some significance. Income and road miles show mixed results but low significance makes any conclusions doubtful. The F-test for significance of the equation is at the 0.05 degree for 1970 and 1972 and at 0.01 for 1971. On the strength of the significance of the equations and the significant negative coefficients of the population parameter the hypothesis that economies of scale exist in road expenditures must be accepted.

Tables 11 and 12 summarize the results of the previous tables. Table 11 gives the percent of coefficients in each category that had the expected sign. Table 12 gives the percent of coefficient in each category and the percent of F-tests that were significant.

TABLE 10

PER CAPITA ROAD EXPENDITURE EQUATIONS 1970-1972

Year	Constant	Population	Area	Density	Urbanization	Income	Road Miles	R^2	F
1970	61.041	-.00125[a]	.00314	.822	-.0419	.00591[b]	.00320	.5296	3.190*
	(2.556)	(1.444)	(.924)	(.783)	(.366)	(2.038)	(.234)		
1971	22.796	-.00185*	.00496[a]	1.527[a]	-.0881	-.000881	.00337	.6260	4.463**
	(1.044)	(2.400)	(1.555)	(1.620)	(.830)	(.331)	(.268)		
1972	100.391[a]	-.00175[a]	.0103[b]	1.232	.0097	-.0104[a]	-.0185	.5911	2.891*
	(1.684)	(1.437)	(2.023)	(.809)	(.539)	(1.444)	(.864)		

TABLE 11

PERCENT OF COEFFICIENTS WITH EXPECTED SIGN

Population	Area	Density	Urbanization	Income	Education	Road Miles
71	100	25	54	75	62	66

TABLE 12

PERCENT OF COEFFICIENTS SIGNIFICANT AT THE 0.20 OR LOWER PROBABILITY LEVEL

Population	Area	Density	Urbanization	Income	Education	Road Miles	F
54	77	20	29	54	5	0	50

As can be seen from these tables, the majority of population coefficients were of the expected sign and significant giving support to the hypothesis. Area was shown to be important in explaining variations in expenditures as was income.

The hypothesis of economies of scale was accepted in four of the eight cases. In two more cases negative population coefficients also support this position. Thus, economies of scale can be expected in government services in nonmetropolitan Utah counties as populations grow. The implications of these results apply to many areas of concern in the development of Utah. This chapter has shown the results of the testing of the hypothesis of this thesis. The next chapter will develop the implications that these findings have upon the issues Utahns currently face.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this thesis is to examine the cost structure of providing governmental services in nonmetropolitan Utah counties to determine whether or not economies of scale exist in the provision of these services. At present, there are several places in nonmetropolitan Utah that are experiencing rapid population growth and several other areas have the potential of rapid growth. It is hoped that this thesis helps to clarify the effects of growth upon public service costs.

The economic theory relative to this topic was reviewed. Production functions were used to show the possible effects of scale changes. It was shown that by increasing all inputs by a constant amount, that output can increase at a rate proportional, less than proportional, or greater than proportional to the increase in inputs. These were then related to the concepts of constant, decreasing, or increasing returns to scale. It was then shown how these concepts relate to the long-run average cost curve. Increasing returns to scale correspond to the negatively sloped portion of the curve and show economies of scale. The flat portion of the curve shows constant returns to scale and the positive sloped portion shows decreasing returns to scale or diseconomies of scale.

Six reasons for the existence of economies of scale were given: (1) specialization of men and machines; (2) reduction in input prices because of volume buying; (3) economical use of by-products; (4)

development of auxiliary facilities; (5) ability of larger firms are able to purchase larger machines which reduce per unit costs; (6) possible unused capacity in capital or management. The reasons were given why diseconomies of scale may eventually set in: (1) limitations of management capability in decision making; (2) increased costs of inputs due to expansion of the industry as more firms take advantage of scale economies; and (3) the effect of externalities.

Two methods of estimating the long-run average cost curve, the time series method and the cross-sectional method, were explained. The cross-sectional method was used in this thesis.

An important topic related to this thesis, that of integration was discussed. It was shown that there are both horizontally and vertically integrated services provided by government units and that the effects of scale changes may be different between the groups. In this thesis the categories of public safety, libraries, parks and recreation, and health and welfare are horizontally integrated services while public works and roads are vertically integrated.

It was hypothesized that there would be economies of scale in the provision of public services in the nonmetropolitan counties of Utah.

The published work in the field was examined and reviewed. The purpose of this literature search was to determine the work that had been done to find out if the work and evidence of others would support the hypothesis and to determine what models and variables may be suited to study the situation in Utah. Several studies found that there were significant economies of scale in government services. In particular, Fisher (6), Gabler (7), Walters (23), and Hirsch (10) found that economies of scale did exist. It was evident from the literature that the majority of the research in this area was concerned with urban places particularly those with populations of 50,000 or more. It was determined that there was a lack of research in nonmetropolitan areas. This thesis will help to fill this gap in the literature and will increase the understanding of the economies of public services provision in nonmetropolitan areas.

In order to test the hypothesis, a series of equations were specified that explained levels of expenditures as functions of population and several other variables. Ordinary least-squares regression techniques were used to estimate the coefficients of the variables. A significant negative coefficient on the population variable was taken to be evidence of economies of scale existing in the particular case. Four of the eight services studied, total expenditures, general government, public safety, and roads were shown to have significant negative coefficients on the population variable and the hypothesis was accepted. Two other categories, libraries and parks and recreation, had population coefficients with negative signs, but t-tests showed the coefficients to be not significant. The other two categories, public works and health and welfare, were found to have positive population coefficients; but, here again, the t-test indicated that population was not a significant variable in explaining variations in expenditures.

Because of the evidence of the existence of economies of scale in four of the areas studied and particularly in the total expenditures category, it can be expected that as the nonmetropolitan counties of Utah experience a period of growth, that scale economies may help to alleviate some of their present financial problems. This may happen as counties are able to mechanize some of their operations or are better able to utilize capacity that they now have. These increased efficiencies may make it possible to lower taxes or provide better quality services at constant tax rates.

The evidence that leads to the acceptance of the hypothesis has some implications which affect the positions and arguments of several interest groups presently active in the state. Some of these positions will be presented and analyzed as to the effect the findings of this thesis have on them.

In Utah there are several groups that advocate a no-growth policy for different areas of the state. These groups have several different reasons for taking this stand among which are environmental, social, and political. Conservationists and environmentalists want to restrict population in many areas to protect and preserve environmental quality, animal habitat, and/or resources. Those who oppose growth on social grounds generally wish to maintain a way of life free from outside interference. Others oppose growth for political reasons such as transfer of power from one area to another because of reapportionment of representation that must result from population changes. Zoning and land-use planning are often advocated by these groups as methods of restricting population or of preserving land in its present state.

An argument has been used by these groups, which in the light of this thesis, is questionable. The claim has been made by the State Division of Community Assistance, Department of Community Affairs (22) in an article concerning development of recreational subdivisions, that long-time residents of an area are forced to pay some of the costs of county services for new residents. The essence of the article is that new people raise county costs, through demanding county services, by an amount greater than they contribute to county revenues through increased property taxes, and, thus, long-time residents are forced to make up the difference. This argument assumes that diseconomies of scale can be expected as counties grow. The evidence of this thesis would refute this hypothesis with evidence that there are economies of scale. These may be very real grounds for opposing population growth in nonmetropolitan Utah. Groups which wish to restrict growth may find it necessary to give primary reasons for opposing growth such as possible damage to the environment. The secondary argument that county costs will be raised causing unfair payments upon the part of long-time residents is invalid.

A second classification of groups involved in this struggle is the developers and those who advocate growth. Developers, of course, are interested in promoting growth because their livelihood depends on it while other groups encourage growth because they feel that the well-being of society would be enhanced.

This thesis tends to support the position of these groups. The argument that per capita costs of providing services are lower in counties with larger populations could be used to build support for resource development or industrial development programs. In fact, the argument could be made that long-time residents of a place could subsidize new people who come to the area because in the long run they would benefit from lower costs of essential county services. This stand is only valid if the lowering of taxes or county costs is part of the policy of the local government.

A question that appears often in Utah is that of consolidation. Frequently, suggestions are made that certain schools or even school districts in the state be consolidated. Although this thesis did not deal with the topic of schools, it is felt that the results are applicable. Consolidation may very well allow for higher quality education. That is, teachers may be more specialized, there may be a broader range of educational opportunities for the students, and several other benefits may result. Economies of scale may lower costs of operation, particularly in areas like administration. In Utah the problem often is one of distance. As pointed out in Chapter III, distance is a critical factor in determining the feasibility of consolidation. In this case as in many others, benefit-cost analysis is useful if it is based on the values the local people place on education and topics such as bussing over long distances. Before steps are taken in this direction, a careful study must be made of all the benefits and costs and attitudes of the people involved.

The above discussion suggests a topic where research similar to this thesis would be helpful in determining the effects of consolidation. Schools were left out of this study because school district boundaries are often not consistent with county boundaries. Another topic of interest would be to examine tax rates in the various counties to see if economies of scale are indicated.

Because of the influence of cities, county governments are often overlooked. In nonmetropolitan areas county governments play an important role in the local economy. The purpose of this thesis was to show whether or not economies of scale existed in the nonmetropolitan counties of Utah. Evidence of their existence was found in several of the services provided. It is expected that this thesis will help officials and citizens to better understand the economies of this group of counties and that better decision making will result.

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